CLAIMS

1. An optical multiplexer/demultiplexer, wherein

plurality of wavelength selecting elements of which the transmission wavelength bands are different from each other and a light reflecting surface are made to face each other, and thereby, an optical guiding means for guiding light by making light being reflected between the light reflecting surface and the respective wavelength selecting elements and for multiplexing or demultiplexing light having different wavelengths is formed,

a transmission means for transmitting light having plurality of wavelengths is coupled to light having plurality of wavelengths or wavelength bands that is guided within the optical guiding means,

plurality of light inputting/outputting means are placed on the same side as the transmission means relative to the optical guiding means in a manner where the direction of the optical axis becomes approximately perpendicular to the direction in which the wavelength selecting elements are aligned, and

a deflection element for converting the direction of the optical axis of light that has transmitted through each of the wavelength selecting elements into one that is parallel to the

direction of the optical axis of the respective light inputting/outputting means, or for converting light that is parallel to the direction of the optical axis of each of the light inputting/outputting means into the direction of the optical axis of light that transmits through each of the wavelength selecting elements is provided between each of the light inputting/outputting means and each of the wavelength selecting elements.

2. The optical multiplexer/demultiplexer according to Claim 1, wherein an antireflection film is provided in the middle of the light path between the transmission means and the optical guiding means.

3. An optical multiplexer/demultiplexer, comprising:

an optical guiding means which is made of a light reflecting surface and plurality of wavelength selecting elements which are aligned in a plane that is parallel to the light reflecting surface, and of which the transmission wavelength bands are different from each other, which guides light by making light be reflected between the light reflecting surface and the respective wavelength selecting elements, and which multiplexes or demultiplexes light having different

wavelengths;

an optical fiber array where a first optical fiber for transmitting light having plurality of wavelengths or wavelength bands and plurality of second optical fibers for transmitting light having particular wavelengths or wavelength bands are aligned in a manner where the optical axis of each optical fiber becomes approximately perpendicular to the plane in which the wavelength selecting elements are aligned; and

one or more deflection element for bending the direction of the optical axis of transmitting light, which are placed so as to face the first and second optical fibers, wherein

the first optical fiber is coupled to light having plurality of wavelengths that diagonally enters into or is emitted from the optical guiding means via the deflection element, and the second optical fibers are respectively coupled to light having respective wavelengths that diagonally enters into or is emitted from the optical guiding means via the deflection elements.

4. The optical multiplexer/demultiplexer according to Claim 3, wherein the deflection element is joined to and integrated with an end surface of the optical fiber array.

5. The optical multiplexer/demultiplexer according to Claim 3, wherein the optical guiding means, the deflection element and the optical fiber array are contained within a case so as to be sealed.

6. An optical multiplexer/demultiplexer, comprising:

an optical guiding means which is made of a light reflecting surface and plurality of wavelength selecting elements which are aligned in a plane that is parallel to the light reflecting surface, and of which the transmission wavelength bands are different from each other, which guides light by making light be reflected between the light reflecting surface and the respective wavelength selecting elements, and which multiplexes or demultiplexes light having different wavelengths;

a transmission means for transmitting light having plurality of wavelengths of which the optical axis is placed so as to be approximately perpendicular to the plane in which the wavelength selecting elements are aligned;

plurality of light emitting elements for respectively outputting light having particular wavelengths of which the optical axes are placed so as to be approximately perpendicular to the plane in which the wavelength selecting elements are

aligned; and

one or more deflection element for bending the direction of the optical axis of transmitting light which is placed so as to face the transmission means and the light emitting elements, wherein

the transmission means is coupled to light having plurality of wavelengths that is diagonally emitted from the optical guiding means via the deflection element, and the light emitting elements emit light having respective wavelengths via the deflection element so that light diagonally enters into the optical guiding means.

7. An optical multiplexer/demultiplexer, comprising:

an optical guiding means which is made of a light reflecting surface and plurality of wavelength selecting elements which are aligned in a plane that is parallel to the light reflecting surface, and of which the transmission wavelengths are different from each other, which guides light by making light be reflected between the light reflecting surface and the respective wavelength selecting elements, and which multiplexes or demultiplexes light having different wavelengths;

a transmission means for transmitting light having plurality of wavelengths of which the optical axis is placed

so as to be approximately perpendicular to the plane in which the wavelength selecting elements are aligned;

plurality of light receiving elements of which the optical axes are placed so as to be approximately perpendicular to the plane in which the wavelength selecting elements are aligned; and

one or more deflection element for bending the direction of the optical axis of transmitting light which is placed so as to face the transmission means and the light receiving element, wherein

the transmission means is coupled to light having plurality of wavelengths that diagonally enters into the optical guiding means via the deflection element and the light receiving elements respectively receive light having respective wavelengths that is diagonally emitted from the optical guiding means via the deflection element.

8. An optical multiplexer/demultiplexer, comprising:

an optical guiding means which is made of a light reflecting surface and plurality of wavelength selecting elements which are aligned in a plane that is parallel to the light reflecting surface, and of which the transmission wavelengths are different from each other, which guides light by making light be reflected

between the light reflecting surface and the respective wavelength selecting elements and which multiplexes or demultiplexes light having different wavelengths;

plurality of light inputting means of which the optical axes are placed so as to be approximately perpendicular to the plane in which the wavelength selecting elements are aligned;

a first transmission means for transmitting light having plurality of wavelengths which is placed in the direction in which the wavelength selecting elements are aligned together with the light inputting means in a manner where the optical axis becomes approximately perpendicular to the plane in which the wavelength selecting elements are aligned;

plurality of light outputting means of which the optical axes are placed so as to be approximately perpendicular to the plane in which the wavelength selecting elements are aligned;

a second transmission means for transmitting light having plurality of wavelengths which is placed in the direction in which the wavelength selecting elements are aligned together with the light outputting means in a manner where the optical axis becomes approximately perpendicular to the plane in which the wavelength selecting elements are aligned and becomes approximately parallel to the direction in which the light inputting means and the first transmission means are aligned;

one or more first deflection element for bending the direction of the optical axis of transmitting light which is placed so as to face the light inputting means and the first transmission means; and

one or more second deflection element for bending the direction of the optical axis of transmitting light which is placed so as to face the light outputting means and the second transmission means, wherein

the light inputting means emits light having each wavelength from among light having plurality of wavelengths via the deflection element so that the light diagonally enters into the optical guiding means and the first transmission means is coupled to the light having plurality of wavelengths that is diagonally emitted from the optical guiding means via the deflection element, and

the second transmission means is coupled to another light having plurality of wavelengths that diagonally enters into the optical guiding means via the second deflection element and the light outputting means receives light having each wavelength from among the other light having plurality of wavelengths that is diagonally emitted from the optical guiding means via the second deflection element.

9. The optical multiplexer/demultiplexer according to Claim 8, wherein

the light having plurality of wavelengths and the other light having plurality of wavelengths are light having plurality of same wavelengths, and

the lengths of the light paths of the light having plurality of wavelengths between the second transmission means and the light outputting means becomes shorter sequentially in order from longest to shortest of the lengths of light paths between the first transmission means and the light inputting means.

10. An optical multiplexer/demultiplexer, comprising:

an optical guiding means which is made of a light reflecting surface, plurality of first wavelength selecting elements which are aligned in a plane that is parallel to the light reflecting surface, and of which the transmission wavelengths are different from each other and plurality of second wavelength selecting elements which are aligned in a plane that is parallel to the light reflecting surface, and of which the transmission wavelengths are different from each other, which guides light by making the light be reflected between the light reflecting surface and the respective first wavelength selecting elements and multiplexes light having different wavelengths and which

guides light by making the light be reflected between the light reflecting surface and the respective second wavelength selecting elements and demultiplexes light having different wavelengths;

a transmission means for transmitting light having plurality of wavelengths;

plurality of light inputting means which are placed in the direction in which the first wavelength selecting elements are aligned in a manner wherein the optical axes become approximately perpendicular to the plane where the first wavelength selecting elements are aligned;

plurality of light outputting means which are placed in the direction in which the second wavelength selecting elements are aligned in a manner wherein the optical axes become approximately perpendicular to the plane where the second wavelength selecting elements are aligned;

one or more first deflection element for bending the direction of the optical axis of transmitting light which is placed so as to face the light inputting means;

one or more second deflection element for bending the direction of the optical axis of transmitting light which is placed so as to face the light outputting means; and

a light branching means which guides light having

plurality of wavelengths that has been multiplexed between the light reflecting surface of the optical guiding means and the first wavelength selecting elements to the transmission means so that the light is coupled to the transmission means and which guides another light having plurality of wavelengths that has been transmitted through the transmission means in between the light reflecting surface of the optical guiding means and the second wavelength selecting elements, wherein

the light inputting means respectively emit light having each wavelength from among light having plurality of wavelengths via the first deflection element so that the light diagonally enters into the first wavelength selecting elements of the optical guiding means, and

the light outputting means respectively receive light having each wavelength from among another light having plurality of wavelengths that has been diagonally emitted from the second wavelength selecting elements of the optical guiding means via the second deflection element.

11. The optical multiplexer/demultiplexer according to Claim 10, wherein the light branching means comprises:

a filter for multiplexing and demultiplexing the light having plurality of wavelengths that is sent from the

transmission means and the other light having plurality of wavelengths that is sent from the transmission means; and

at least one light transferring means of a light transferring means such as an optical fiber, a core, a prism or a mirror for guiding light having plurality of wavelengths that has been multiplexed between the light reflecting surface of the optical guiding means and the first wavelength selecting elements to the transmission means, and a light transferring means such as an optical fiber, a core, a prism or a mirror for guiding the other light having plurality of wavelengths that has been separated by the filter to the second wavelength selecting elements of the optical guiding means.

12. The optical multiplexer/demultiplexer according to Claim 10, wherein the transmission means is formed of an optical fiber, the light inputting means are formed of light emitting elements and the light outputting means are formed of light receiving elements.

13. An optical multiplexer/demultiplexer, comprising:

an optical guiding means which is made of a light reflecting surface and plurality of first wavelength selecting elements which are aligned in a plane that is parallel to the light

reflecting surface, and of which the transmission wavelengths are different from each other, which guides light by making light be reflected between the light reflecting surface and the respective first wavelength selecting elements and which multiplexes light having different wavelengths;

an optical guiding plate which is placed so as to face the surface of the optical guiding means on the side opposite the light reflecting surface and so as to become approximately parallel to the first wavelength selecting elements;

a transmission means for transmitting light having plurality of wavelengths;

plurality of light emitting elements which are placed on the optical guiding plate in the direction in which the first wavelength selecting elements are aligned in a manner where the optical axes of the light emitting elements are directed in the direction approximately perpendicular to the optical guiding plate;

a light receiving element which is placed on the optical guiding plate in a manner where the optical axis of the light receiving element is directed in the direction approximately perpendicular to the optical guiding plate;

one or more deflection element for bending the direction of the optical axis of transmitting light which is placed so

as to face the light emitting elements;

plurality of second wavelength selecting elements which are provided between the light receiving element and the optical guiding plate and of which the transmission wavelengths are different from each other; and

a light branching means which guides light having plurality of wavelengths that has been multiplexed between the light reflecting surface of the optical guiding means and the wavelength selecting elements to the transmission means so that the light is coupled to the transmission means and which guides another light having plurality of wavelengths that has been transmitted through the transmission means to the optical guiding plate, wherein

the light emitting elements respectively emit light of each wavelength from among light having plurality of wavelengths via the first deflection element so that the light diagonally enters into the first wavelength selecting elements of the optical guiding means, and

the light outputting means respectively receive light having each wavelength from among another light having plurality of wavelengths that has been guided within the optical guiding plate via the second deflection element.

14. The optical multiplexer/demultiplexer according to Claim 1, 3, 6, 7, 8, 10 or 13, wherein the optical guiding means has the respective wavelength selecting elements formed on the front surface of a transparent substrate and the light reflecting surface formed on the rear surface of the transparent substrate.

15. The optical multiplexer/demultiplexer according to Claim 1, 3, 6, 7, 8, 10 or 13, wherein the optical guiding means has a transparent second substrate where plurality of the wavelength selecting elements are aligned on the front surface joined to a transparent first substrate where the light reflecting surface is formed on the rear surface.

16. The optical multiplexer/demultiplexer according to Claim 1, 3, 6, 7, 8, 10 or 13, wherein the optical guiding means has plurality of transparent second substrates where the wavelength selecting elements are individually formed on the respective front surfaces aligned on and joined to a transparent first substrate where the light reflecting surface is formed on the rear surface.

17. The optical multiplexer/demultiplexer according to Claim 1, 3, 6, 7, 8, 10 or 13, wherein the optical guiding means has

the respective wavelength selecting elements formed between a pair of transparent substrates that overlap and has the light reflecting surface formed on the rear surface of the substrate that is located on the rear surface side of the substrates.

18. The optical multiplexer/demultiplexer according to Claim 1, 3, 6, 7, 8, 10 or 13, wherein the surface of the optical guiding means, on which the wavelength selecting elements are formed, and the deflection element are made to face each other with a spacer intervening between the optical guiding means and the deflection element.

19. The optical multiplexer/demultiplexer according to Claim 18, wherein the spacer is formed so as to be integrated with the deflection element.

20. The optical multiplexer/demultiplexer according to Claim 1, 3, 6, 7, 8, 10 or 13, wherein the surfaces of the respective wavelength selecting elements are coated with a protective layer.

21. An optical multiplexer/demultiplexer, comprising:

an optical guiding means which is made of a light reflecting

surface that is formed between a pair of transparent substrates and plurality of wavelength selecting elements which are aligned on the outer surfaces of the two transparent substrates and of which the transmission wavelengths are different from each other, and which guides light within the respective transparent substrates by making light be reflected between the light reflecting surface and the respective wavelength selecting elements;

a transmission means for transmitting light having plurality of wavelengths or wavelength bands which are placed in a manner where the optical axis becomes approximately perpendicular to the plane in which the wavelength selecting elements on one transparent substrate of the pair of transparent substrates are aligned;

plurality of first light inputting/outputting means which are placed on the same side as the transmission means relative to the optical guiding means in a manner where the optical axis becomes approximately perpendicular to the plane in which the wavelength selecting elements on the one transparent substrate are aligned;

plurality of second light inputting/outputting means which are placed on the side opposite the transmission means relative to the optical guiding means in a manner where the

optical axis becomes approximately perpendicular to the plane in which the wavelength selecting elements on the other transparent substrate are aligned;

one or more first deflection element for bending the direction of the optical axis of transmitting light which is placed so as to face the transmission means and the first light inputting/outputting means; and

one or more second deflection element for bending the direction of the optical axis of transmitting light which is placed so as to face the second light inputting/outputting means, wherein

the transmission means is coupled to light having plurality of wavelengths within the two transparent substrates of the optical guiding means via the first deflection element, the first light inputting/outputting means is coupled to light that transmits the respective wavelength selecting elements which are aligned on one surface of the optical guiding means via the first deflection element, and the second light inputting/outputting means is coupled to light that transmits the respective wavelength selecting elements which are aligned on the other surface of the optical guiding means via the second deflection element.

22. An optical multiplexer/demultiplexer, comprising:

an optical guiding means which is made of a light reflecting surface that is formed between a pair of transparent substrates and plurality of wavelength selecting elements which are aligned on the outer surfaces of the two transparent substrates and of which the transmission wavelengths are different from each other, and which guides light within the respective transparent substrates by making light be reflected between the light reflecting surface and the respective wavelength selecting elements;

a first optical fiber array where a first optical fiber for transmitting light having plurality of wavelengths or wavelength bands and plurality of second optical fibers for transmitting light having particular wavelengths or wavelength bands are aligned and which is placed in a manner where the optical axis of each optical fiber becomes approximately perpendicular to the plane in which the wavelength selecting elements on one transparent substrate of the pair of transparent substrates are aligned;

a second optical fiber array where plurality of third optical fibers for transmitting light having particular wavelengths or wavelength bands are aligned and which is placed in a manner where the optical axis of each optical fiber becomes

approximately perpendicular to the plane in which the wavelength selecting elements on the other transparent substrate are aligned;

one or more first deflection element for bending the direction of the optical axis of transmitting light which is placed so as to face the first optical fiber and the second optical fibers; and

one or more second deflection element for bending the direction of the optical axis of transmitting light which is placed so as to face the third optical fibers, wherein

the first optical fiber is coupled to light having plurality of wavelengths within the two transparent substrates of the optical guiding means via the first deflection element, the second optical fibers are coupled to light that transmits the respective wavelength selecting elements which are aligned on one surface of the optical guiding means via the first deflection element, and the third optical fibers are coupled to light that transmits the respective wavelength selecting elements which are aligned on the other surface of the optical guiding means via the second deflection element.

23. The optical multiplexer/demultiplexer according to Claim 1, 3, 6, 7, 8, 10, 13, 21 or 22, wherein the deflection elements

are formed of lenses which are not rotationally symmetrical around their center axes.

24. The optical multiplexer/demultiplexer according to Claim 1, 3, 6, 7, 8, 10, 13, 21 or 22, wherein the deflection elements are formed of spherical lenses, aspherical lenses or anamorphic lenses where the centers in the cross sections of transmitting light fluxes are shifted from their optical axes.

25. The optical multiplexer/demultiplexer according to Claim 1, 3, 6, 7, 8, 10, 13, 21 or 22, wherein the deflection elements are formed of prisms and lenses.

26. The optical multiplexer/demultiplexer according to Claim 25, wherein the prisms are formed on one surface of a transparent substrate and the lenses are provided on the other surface of the transparent substrate so as to face the prisms.

27. The optical multiplexer/demultiplexer according to Claim 25, wherein the prisms are formed on and integrated with a surface of the optical guiding means and the lenses are placed so as to face the prisms.

28. The optical multiplexer/demultiplexer according to Claim 1, 3, 6, 7, 8, 10, 13, 21 or 22, wherein the wavelength selecting elements are formed of filters or diffraction elements.

29. A manufacturing method for an optical multiplexer/demultiplexer that comprises an optical guiding means which is made of a light reflecting surface and plurality of wavelength selecting elements which are aligned in a plane that is parallel to the light reflecting surface, and of which the transmission wavelengths are different from each other, which guides light by making the light be reflected between the light reflecting surface and the respective wavelength selecting elements, and which multiplexes or demultiplexes light having plurality of wavelengths, wherein

the optical guiding means is fabricated according to:

the step of forming a wavelength selecting element layer by aligning plurality of the wavelength selecting elements in thin film form of which the transmission wavelength bands are different from each other on a transparent substrate where the light reflecting surface is formed on the rear surface; and

the step of joining another transparent substrate to the surface of the wavelength selecting element layer so as to place the wavelength selecting element layer in between the substrates

that make up a pair.

30. A manufacturing method for an optical multiplexer/demultiplexer that comprises an optical guiding means which is made of a light reflecting surface and plurality of wavelength selecting elements which are aligned in a plane that is parallel to the light reflecting surface, and of which the transmission wavelengths are different from each other, which guides light by making the light be reflected between the light reflecting surface and the respective wavelength selecting elements, and which multiplexes or demultiplexes light having plurality of wavelengths, wherein

plurality of optical guiding means are fabricated by cutting a pair of parent substrates that have been layered after placing a wavelength selecting element layer that has been formed by aligning plurality of the wavelength selecting elements in thin film form of which the transmission wavelength bands are different from each other in between the parent substrates in an integrating manner.

31. A manufacturing method for an optical multiplexer/demultiplexer that comprises an optical guiding means which is made of a light reflecting surface and plurality

of wavelength selecting elements which are aligned in a plane that is parallel to the light reflecting surface, and of which the transmission wavelengths are different from each other, which guides light by making the light be reflected between the light reflecting surface and the respective wavelength selecting elements, and which multiplexes or demultiplexes light having plurality of wavelengths, wherein

the optical guiding means is fabricated according to the step of forming a wavelength selecting element layer by aligning plurality of the wavelength selecting elements in thin film form of which the transmission wavelength bands are different from each other on a transparent substrate where the light reflecting surface is formed on the rear surface.

32. A manufacturing method for an optical multiplexer/demultiplexer that comprises an optical guiding means which is made of a light reflecting surface and plurality of wavelength selecting elements which are aligned in a plane that is parallel to the light reflecting surface, and of which the transmission wavelengths are different from each other, which guides light by making the light be reflected between the light reflecting surface and the respective wavelength selecting elements, and which multiplexes or demultiplexes

light having plurality of wavelengths, wherein

the optical guiding means is fabricated according to:

the step of forming a wavelength selecting element layer by aligning plurality of the wavelength selecting elements in thin film form of which the transmission wavelength bands are different from each other on a transparent second substrate; and

the step of joining the second substrate to a transparent first substrate where the light reflecting surface is formed on the rear surface.

33. A manufacturing method for an optical multiplexer/demultiplexer that comprises an optical guiding means which is made of a light reflecting surface and plurality of wavelength selecting elements which are aligned in a plane that is parallel to the light reflecting surface, and of which the transmission wavelengths are different from each other, which guides light by making the light be reflected between the light reflecting surface and the respective wavelength selecting elements, and which multiplexes or demultiplexes light having plurality of wavelengths, wherein

the optical guiding means is fabricated according to:

the step of forming plurality of the wavelength selecting

elements in thin film form of which the transmission wavelength bands are different from each other on plurality of transparent second substrates, respectively; and

the step of aligning and joining plurality of the second substrates having the wavelength selecting elements of which the transmission wavelength bands are different from each other on and to a transparent first substrate where the light reflecting surface is formed on the rear surface.

34. The manufacturing method for an optical multiplexer/demultiplexer according to Claim 33, wherein the wavelength selecting elements of which the transmission wavelength bands are different from each other are formed on plurality of parent substrates, and the second substrates, on which the wavelength selecting elements are formed, are formed by cutting the respective parent substrates in the step of forming the wavelength selecting elements on the second substrates.

35. The manufacturing method for an optical multiplexer/demultiplexer according to Claim 33, wherein the wavelength selecting elements of which the transmission wavelength bands are different from each other are formed on

plurality of parent substrates, and these parent substrates are aligned so as to be cut in a collective manner, and thereby, pairs of second substrates, where the wavelength selecting elements of which the transmission wavelength bands are different from each other are formed, are formed in the step of forming the wavelength selecting elements on the second substrates.

36. A manufacturing method for an optical multiplexer/demultiplexer that comprises an optical guiding means for guiding light by making the light be reflected between a light reflecting surface and plurality of wavelength selecting elements of which the transmission wavelengths are different from each other and for multiplexing/demultiplexing light having plurality of wavelengths, wherein the respective wavelength selecting elements are placed between a first substrate where the light reflecting surface is formed on the rear surface and a second substrate where plurality of prisms that become deflection elements are formed on the front surface, comprising:

the step of layering plurality of plates and of processing the end surfaces of the layered plates so that the end surfaces become of plane form that incline relative to the direction

in which the plates are layered;

the step of realigning the plates and thereby of forming an inverted pattern of plurality of the prisms from an array of the inclining end surfaces; and

the step of forming the prisms on the front surface of the second substrate by using the realigned plates as at least a portion of a die.